Analysis of Overall Rating Changes
September, 2007

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Introduction:

This report summarizes an assessment of expected rating changes due to the new office model and associated Portfolio Manager updates. The significant updates to the tool that are expected to change ratings include:

- New office model (including bank/financial institutions and courthouse)
- New parking garage model
- New source energy conversion factors
- New approach to weather adjustments for all ratable buildings
- Corrected coefficient in the K-12 Schools model
- New methodology for secondary spaces
- Methodology for combing multiple primary spaces of the same space type

Aggregate Statistics[1]:

The rating change report is computed across the universe of rated buildings in PM. In order to collect this data, SRA implements a series of screens to remove test and sample facilities from the analysis. In addition, a variety of filters are applied in-house to remove suspect/bad data. For example, buildings with physically impossible values for the density of dormitory rooms and office buildings with zero workers are removed from the analysis. A list of the filters applied to the data is shown in **Table A** in the Appendix. After the filters are applied there are 29,483 buildings included in the analysis. Basic characteristics for these buildings are as follows:

- The average rating change across all 29,483 buildings is +5.2
    - 71.5% experience a rating increase – the average is +8.4
    - 17.5% experience a rating decrease – the average is -4.5
    - 11% do not experience a change in rating
- The following table shows the average rating change by space type.

Average Rating Change by Space Type

Building Type	Average Rating Change	Number of Buildings
K-12 School	8.5	11,275
Office	6.4	9,015
Hospital (Acute Care, Children's)	2.1	1,152
Medical Office	0.8	479
Residence Hall/Dormitory	0.4	434
Warehouse and Storage	0.4	298
Hotel/Motel	-0.2	2,585
Supermarket/Grocery	-0.3	3,582
Bank	-2.1	475
Court	-3.5	188
Grand Total	**5.2**	29,483

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[1] The aggregate statistics are based on data pulled in May of 2007. The data reflect the most recent 12 month period for each building, as of May 2007.

- The degree of change is different for each space type, due to unique space type models. Because the Office model will experience the greatest changes, these buildings are subject to the larger rating changes. **Table B** (in the Appendix) presents additional detail on each space type.
- The majority of space types experienced a change of 5 points or fewer. However, due to changes in the benchmarking equation, Offices/Banks/Courts and Schools experience slightly larger changes, with the majority falling within +/- 10 points. The following tables show a different perspective on rating changes by space type.

Number of Buildings and Degree of Rating Changes by Space Type

Space Type	Total # Bldgs	<= +/- 5 points # Bldgs	%	> +/- 15 points # Bldgs	%
Hospital (Acute Care, Children's)	1,152	963	84%	5	0%
Hotel/Motel	2,585	2,369	92%	37	1%
Medical Office	479	413	86%	9	2%
Residence Hall/Dormitory	434	378	87%	4	1%
Supermarket/Grocery	3,582	3,459	97%	4	0%
Warehouse and Storage	298	249	84%	8	3%

Space Type	Total # Bldgs	<= +/- 10 points # Bldgs	%	> +/- 25 points # Bldgs	%
Bank	475	359	76%	8	2%
Court	188	136	72%	4	2%
K-12 School	11,275	7,094	63%	192	2%
Office	9,015	6,232	69%	226	3%

- The rating changes are close to normally distributed around zero. This is an expected outcome. The changes are typically small, and may cause an individual building's rating to increase or decrease. **Figure A** (see Appendix) shows the distribution of rating changes across all space types.
  - o Offices and K-12 schools show the widest spread in distribution across ratings. Those buildings that experience extreme changes in ratings (> 60 absolute delta) are being investigated further and are most likely due to extreme or false data which would ultimately mark them as ineligible for a label.
- As the distributions indicate, there are a handful of buildings with extreme changes (i.e. 50 points or more). The number of buildings with very large changes is well below 1 % of the total population. From a technical standpoint this degree of change is within the expected range. It is not feasible to examine each individual building. However, if there are questions on specific outliers, additional investigations can be performed.
- Specific reports on the characteristics and changes for each sector are provided under separate cover.

Label Information:
- In the sample, there are a total of 3,201 buildings that have earned the ENERGY STAR
- 1,303 buildings have earned the ENERGY STAR in 2006 or 2007. Of these:
  - o 1,202 currently have and will maintain a 75 or higher
  - o 44 currently have a 75 or higher and will drop below 75
  - o 57 currently have a rating below 75
    - After the changes, 38 of these will have ratings of 75 or higher

- All 44 buildings that have earned a 2006 or 2007 label, currently have a rating of 75 or higher, and will drop below a 75 after the changes are made are listed in the appendix (**Table C**). The list identifies the space type and primary contact information.

Description of technical changes and expected impacts to ratings:

These impacts address each specific change in isolation from other changes. *For individual buildings in Portfolio Manager that are subject to more than one of these changes, the exact combined impact cannot be predicted without a unique review.*

1. New Model for Office Space, Bank/Financial Institutions, and Courthouses

Change: The office model has been updated from the previous model that used CBECS 1999 data to a new model that uses CBECS 2003 data. The same regression model is used to rate offices, banks and financial centers, and courthouses. The update includes a new model format that is based on source energy per square foot instead of the natural log of total source energy. In addition, whenever a new regression model is developed with a new CBECS data set the individual adjustments for characteristics such as workers and PCs changes slightly, and the tables used to lookup ratings are adjusted as well.

Under the old model, banks and financial centers were given a flat allowance for energy use relative to offices. Buildings less than 20,000 square feet were classified as banks, and buildings greater than 20,000 square feet were classified as financial centers. A different allowance was applied to each. The new methodology does not distinguish between "bank" and "financial center." Under the new model, an allowance is applied to a bank or financial center that is less than 50,000 square feet. Additionally, the size of the allowances depends on the size of the bank and the occupant (worker) density.

Under the old methodology, courthouses were given a flat adjustment upward. The new 2003 data do not support this adjustment. Courts will now be treated the same as offices.

Impact to Office Ratings: The change in an individual building will depend on its specific operating characteristics. However, for an average office building, the new model will yield a slightly higher rating due to the new data and the new model format.

- Building Size – larger buildings are likely to see more of an increase in their rating. In contrast, small buildings may see a decrease.
- Operating Hours – buildings with long operating hours are likely to see larger increases in ratings as compared with buildings with lower hours of operation.
- Worker Density – buildings with very low worker density (the number of workers per square foot) are likely to see larger increases to their ratings than buildings with high worker densities. Buildings with high worker density may see a decrease.
- Personal Computers – The impact of the number and density of personal computers is similar between the old and new models. Buildings with low PC density may be more likely to see slightly larger increases in their ratings.
- Refrigeration – The new model does *not* require a new input, however the estimation of the regression equation incorporated the impact of refrigeration. Each building is

effectively given an average allowance for refrigeration. Those buildings with much greater than average refrigeration may rate lower and vice versa.

- HDD – Buildings located in climates with very high HDD are more likely to see a rating increase.

Impact to Bank Ratings: The transition from a flat allowance to an adjustable allowance means that, on average banks are not given as large of an allowance as they were before, relative to offices. Therefore, Banks are expected to see a similar rating, or a slight decrease. The change in division between large and small banks has moved from 20,000 to 50,000. This means that resulting rating change for a bank will depend on its size. The largest banks are likely to see smaller decreases or even increases in their ratings. Banks between 20,000 and 50,000 square feet are more likely to see decreases. Trends in banks relative to operating characteristics will be similar to offices, however, they will differ slightly depending on the size of the bank.

Impact to Courthouse Ratings: Under the old methodology courts received an inflated energy allowance. Under the new method, they do not get this allowance. In aggregate this will have the effect of producing lower ratings. However, this decrease is in part off-set by the other updates to the office model, as discussed above, which generally produce higher ratings.

2. New parking garage model

Change: The parking garage model has been modified; the old methods used a statistical regression based on CBECS 1992 data. The updated approach assigns an engineered allowance for lighting and ventilation, which varies based on the type of parking structure (open lot, enclosed parking garage, and non-enclosed parking garage).

Impact to Ratings: Depending on the characteristics of a particular garage, the new methodology may result in a net increase or decrease in rating.

- Garage Workers – there is a current input for number of workers in the garage which is commonly misinterpreted to mean number of parking spaces rather than the number of parking attendants. If users have erroneously entered the number of parking spaces, they will likely see a decrease in their rating. This is because they are currently getting an "inflated" allowance due to the high value for number of workers.

3. New source energy conversion factors

Change: EPA updated the source energy conversions to stay as accurate as possible with published reference values from the Department of Energy. Please note that changes are applied the same way to all buildings and the reference population (i.e. lookup table). The changes were specific to each fuel, based on the most recent reference documents, such as EIA's Annual Energy Review. All factors either stay the same or increase slightly. The increases range as high as 10% and depend on the specific fuel type. No factors went down.

Impact to Ratings: Because the changes are applied uniformly, they are not expected to impact ratings by more than +/- 5 points. However, because each fuel's conversion factor changed by a different percent, the exact change in a given building may depend on its fuel mix. These values will change over time, and the purpose of the update is to create the most equitable comparison.

4. New weather normalization procedure

Change: The old methodology computed weather-normalized energy consumption, and ran the benchmarking equations using 30-year average Heating Degree Days (HDD) and Cooling Degree Days (CDD). This means that the "prediction" from the regression model was based on average HDD and CDD values and that the "actual" energy use from the reported meter data was weather normalized so that it could be compared with the prediction. The new methodology uses actual as-experienced HDD and CDD values in the regression models and therefore can use actual billed energy consumption for the period being rated, without adjustment. By making fewer adjustments to the data, less error is introduced to the rating. The weather normalized energy consumption is still included in Portfolio Manager for display purposes.

Impact to Ratings: The impact of this change is generally small (with in +/- 5 points). However, effects will be more pronounced in locations where the climate varies substantially from one year to the next, meaning the current year's weather may be very different from the 30-year average weather. In these locations, the net adjustment for weather is proportionately larger (under any method), and when the method changes there are greater impacts. Generally the new methodology is considered superior and less prone to error. The weather adjustments will typically result in slightly lower ratings. This effect is pronounced in smaller buildings, and in buildings with actual HDD and CDD values substantially below the 30-year average.

5. Adjustment to K-12 coefficient on HDD

Change: There was an error in the HDD coefficient for the K-12 model. The new (correct) coefficient is higher than the old coefficient.

Impact to Ratings: Because the coefficient was increased, this will result in a rating increase. The effect will be pronounced in areas with higher values for HDD.

6. New methodology for secondary spaces

Change: Under the old methodology, the energy allowance for a secondary space was added to the predicted energy use computed by the regression. Under the new methodology, the energy allowance of the secondary space is subtracted from the actual (reported) total energy consumption. The old methodology was more conservative, which means that it typically was under-estimating the rating. The new method is considered more accurate and less punitive.

Impact to Ratings: The new method will tend to result in higher ratings. The impact will be small; however, buildings with a higher percentage square foot of secondary space may experience a larger increase in rating.

7. Methodology for combing multiple primary spaces of the same space type:

Change: Under the old methodology, a prediction was computed for each space separately and then the predictions of energy use were added together (i.e. the regression model was applied more than once for buildings with multiple primary spaces). Because energy use per square foot is correlated with building size, this old method fails to account for the full size of the building. Under the new methodology, the operating characteristics for all spaces of the same space type

are combined into one aggregate space and then the regression equation is applied once to get one prediction. This new methodology will incorporate gross square foot more accurately.

Impact to Ratings: Larger buildings actually consume more energy *per square foot*; this is called a diseconomy of scale. Therefore, the old methodology failed to provide enough of an allowance to buildings with multiple primary spaces. Under the old method, the ratings were systematically too low. The new methodology will provide a more accurate prediction, which will be larger. As a result, buildings that have multiple primary spaces of the same space type may experience rating increases.

Please note that in the review of changes a number of office buildings were identified with over 30 offices spaces. The division of a building into 30 spaces does not result in a superior prediction and should be discouraged because it introduces greater possibility for user-entry data errors.

New User Entry Requirements:

The new methodologies for Offices and Parking Garages will require new user inputs. When the changes occur, Portfolio Manager will populate these entries with default values. In order to receive an accurate rating (or apply for a label), users will be required to enter correct values for these fields. New entry requirements are described below.

Offices, Bank/Financial Institutions, and Courts

Under the new methodology, users will be required to enter values for the percent of the building that is heated and the percent that is air-conditioned. These entries will be based on drop-down menus with 3 options:

- Not heated (Not Air-Conditioned)
- < 50% Heated (< 50% Air Conditioned)
- >= 50% Heated (>=50% Air Conditioned)
- ***The default will be >=50% Heated and Air Conditioned.***

Parking Garages and Parking lots
Under the new methodology, all types of parking (from enclosed garages to open parking lots) are combined into a single space. The following pieces of information will be required and are defaulted as noted below.
- Total gross floor area of parking
  - ***No default, this variable exists***
- Parking ft^2 that is enclosed
  - ***Default computed from "number of floors below ground"***
- Parking ft^2 that is not enclosed (with a roof and no sides)
  - ***Default computed from "number of floors above ground"***
- Parking ft^2 that is open (no roof and no sides)
  - ***Default computed from the Open Parking Lot gross floor area***
- Hours of Access (total hours when it is possible for a vehicle to enter/exit)
  - ***Default computed from "Hours of Operation" variable***

Table A. Filters applied to data before aggregate statistics were computed.

Variable	Criteria
New Weather Normalized Source Energy Use per Square Foot	< 10
New Weather Normalized Source Energy Use per Square Foot	> 3000
Parking Number of Workers	< 10
Parking Number of Workers/1000 Square Foot	> 1
Office Occupants per 1000 sq ft	> 50
Office Occupants per 1000 sq ft	< 0.2
Office PCs per 1000 sq ft	> 50
Office PCs per 1000 sq ft	< 0.2
Office Weekly Operating Hours	< 30
Dorm Rooms per 1000 sq ft	> 12
K-12 Students per 1000 sq ft	> 50
K-12 Students per 1000 sq ft	< 2

Table B: Average Changes (positive and negative) by space type

Building Type	Change	Avg Delta	StdDev Delta	Max Delta	Min Delta	# Bldgs
Bank	Negative	-8.1	5.8	-1	-28	263
	No Change	0.0	0.0	0	0	50
	Positive	7.0	6.1	35	1	162
Bank Total		-2.1	9.0	35	-28	475
Court	Negative	-9.2	7.1	-1	-40	116
	No Change	0.0	0.0	0	0	8
	Positive	6.5	5.6	25	1	64
Court Total		-3.5	9.8	25	-40	188
Hospital (Acute Care, Children's)	Negative	-3.3	3.3	-1	-22	166
	No Change	0.0	0.0	0	0	165
	Positive	3.7	2.7	16	1	821
Hospital (Acute Care, Children's) Total		2.1	3.7	16	-22	1,152
Hotel/Motel	Negative	-4.0	5.2	-1	-47	784
	No Change	0.0	0.0	0	0	540
	Positive	2.1	2.3	28	1	1,261
Hotel/Motel Total		-0.2	4.2	28	-47	2,585
K-12 School	Negative	-5.0	6.3	-1	-65	648
	No Change	0.0	0.0	0	0	518
	Positive	9.9	6.7	66	1	10,109
K-12 School Total		8.5	7.6	66	-65	11,275
Medical Office	Negative	-5.7	7.4	-1	-45	88
	No Change	0.0	0.0	0	0	114
	Positive	3.1	2.8	19	1	277
Medical Office Total		0.8	5.1	19	-45	479
Office	Negative	-5.4	5.9	-1	-80	1,677
	No Change	0.0	0.0	0	0	619
	Positive	9.9	6.9	58	1	6,719
Office Total		6.4	8.9	58	-80	9,015
Residence Hall/Dormitory	Negative	-4.0	4.7	-1	-38	124
	No Change	0.0	0.0	0	0	81
	Positive	2.9	2.4	16	1	229
Residence Hall/Dormitory Total		0.4	4.3	16	-38	434
Supermarket/Grocery	Negative	-2.5	2.4	-1	-21	1,224
	No Change	0.0	0.0	0	0	1,052
	Positive	1.5	1.1	18	1	1,306
Supermarket/Grocery Total		-0.3	2.3	18	-21	3,582
Warehouse and Storage	Negative	-3.8	3.8	-1	-21	94
	No Change	0.0	0.0	0	0	69
	Positive	3.6	4.5	31	1	135
Warehouse and Storage Total		0.4	4.9	31	-21	298
Grand Total		**5.2**	**8.1**	**66**	**-80**	**29,483**

Table C. All buildings currently with a 2006 or 2007 label that will drop below a 75 once changes occur on October1, 2007.

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Figure A. Distribution of Change in Rating Across Space Types

Delta Bin	Bank	Court	Hospital	Hotel/Motel	K-12 School	Med Office	Office	Dormitory	Supermarket	Warehouse	Grand Total
-100											
-90											
-80							2				2
-70						2					2
-60											
-50				2	1	1	2				6
-40		1		3	6	1	8	1			20
-30	9	6	1	11	6	3	30	1	1	1	69
-20	72	37	7	51	50	7	163	4	18	5	414
-10	182	72	158	717	583	76	1,472	118	1,205	88	4,671
0	50	8	165	540	518	114	619	81	1,052	69	3,216
10	127	56	798	1,242	5,993	274	4,141	226	1,304	126	14,287
20	27	4	23	17	3,344	3	2,126	3	2	7	5,556
30	6	4		2	723		350			1	1,086
40	2				48		71			1	122
50							22				22
60							9				9
70						1					1
90											
100											
Grand Total	475	188	1,152	2,585	11,275	479	9,015	434	3,582	298	29,483